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CLASS 20-27

# CANADIAN PATENT

## ROOF

Christian Arne, Chicago, Illinois, U. S. A.

Granted to Chicago Bridge & Iron Company, Chicago, Illinois, U. S. A.

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No. OF CLAIMS 6

This invention relates to a novel circular roof and components thereof suitable for covering large areas or structures such as public exhibition halls, water reservoirs and cylindrical oil storage tanks. More particularly, it is concerned with a roof composed of one or more annular rings of plates of selected sizes and shapes such that the entire roof can be constructed from only three basic plates.

In the construction of roofs spanning large areas it has been customary to build the roof up from a variety of components, by means of roof girders, purlins, deck plates and the like. The most inexpensive roofs are those in which the roof can be supported intermittently by means of columns, because the cost of trusses or other expedients for spanning large areas without utilizing intermittently spaced columns becomes prohibitive.

In accordance with this invention there is provided an inexpensive dome type roof for use where intermittent support columns can be tolerated. The invention includes a plate with sufficient resistance to vertical bending to support not only itself but also adjoining plates not having such resistance. The plates can be utilized, without any change in unit dimensions, in a large number of roofs of varying sizes.

The roof generally comprises three annular rings of plates, although a lesser or greater number can be employed. Only three different types of plates need be used to form the roof, namely, stiffened flanged trapezoidal or rectangular plates having sufficient vertical section to be capable of resisting bending from normal dead and live loads and non-stiffened trapezoidal plates

and non-stiffened rectangular plates each having insufficient vertical section to be capable of resisting bending from normal dead and live loads. These plates are arranged in a repeating ordered sequence. The number of each type of plate in each ring is dependent upon its distance from the center of the roof.

Other advantages will be seen when reference is made to the remainder of the specification and the drawings.

In the drawings:

Figure 1 is a perspective view of a curved flanged trapezoidal plate which is used in the construction of a curved roof herein described;

Figure 2 is a perspective view of a curved trapezoidal plate for use with the curved flanged trapezoidal plate of Figure 1;

Figure 3 is a perspective view of a curved rectangular plate for use with the curved flanged trapezoidal plate of Figure 1;

Figure 4 is a cross-sectional view taken along line 4-4 of Figure 1;

Figure 5 is a cross-sectional view taken along line 5-5 of Figure 13 showing the mode of attachment of the plates of Figures 2 and 3 to the plate of Figure 1;

Figure 6 is a perspective view of an alternative embodiment of the flanged trapezoidal plate shown in Figure 1 which is used in the construction of a substantially flat roof herein described;

Figure 7 is a perspective view of a flat trapezoidal plate for use with the flat trapezoidal plate of Figure 6;

Figure 8 is a perspective view of a flat rectangular plate for use with the flat trapezoidal plate of Figure 6;

Figure 9 is a cross-sectional view taken along line 9-9 of Figure 6;

Figure 10 is a cross-sectional view taken along line 10-10 of Figure 6;

Figure 11 is a cross-sectional view showing the mode of attachment of the plates of Figures 7 and 8 to the flanged plate of Figure 6;

Figure 12 is a plan view of a portion of the roof of the invention showing the arrangement of the plates in annular rings;

Figure 13 is a detailed plan view of a portion of the roof of the invention showing the repeating ordered sequence of the plates in each annular ring;

Figure 14 is a cross-sectional view taken along line 14-14 of Figure 13;

Figure 15 is a perspective view of a curved flanged rectangular plate which is a modification of the plate shown in Figure 1;

Figure 16 is a cross-sectional view taken along line 16-16 of Figure 15;

Figure 17 is a cross-sectional view taken along line 17-17 of Figure 15;

Figure 18 is a perspective view of an arched flanged rectangular plate which is a modification of the plate shown in Figure 6; and

Figure 19 is a cross-sectional view taken along line 19-19 of Figure 18.

Referring to the drawings, there is shown in Figures 12, 13 and 14 a roof 1 adapted to cover a circular area or structure. The roof 1, in the exemplified embodiments, is composed of three annular rings 2, 3 and 4. Each of these rings is composed of a plurality of segments or plates which take the form of plates 5, 6 and 7 shown in Figures 1, 2 and 3, respectively. Annular ring 2 contains plates 5, 6 and 7 which are arranged in a repeating ordered sequence as follows: a stiffened, flanged or dished trapezoidal plate referred to generally as 5, a non-stiffened trapezoidal plate 6, another stiffened flanged or dished trapezoidal plate 5, a non-stiffened, substantially rectangular plate 7, and so on. In all, annular ring 2 consists of twenty stiffened flanged or dished trapezoidal plates 5, twelve non-stiffened trapezoidal plates 6, and eight non-stiffened, substantially rectangular plates 7. Annular ring 3 contains plates 5 and 7 which are arranged in a repeating ordered sequence as follows: a stiffened, flanged or dished trapezoidal plate 5, a non-stiffened, substantially rectangular plate 7, and so on. Annular ring 3 consists of thirty-two stiffened, flanged or dished trapezoidal plates 5 and thirty-two non-stiffened substantially rectangular plates 7. Annular ring 4 contains plates 5 and 7 in a repeating ordered sequence as follows: a stiffened, flanged or dished trapezoidal plate 5, two non-stiffened, substantially rectangular plates 7, and so on. Annular ring 4 consists of thirty-two stiffened flanged or dished rectangular plates and sixty-four non-stiffened rectangular plates.

All of the plates in each annular ring are attached to each other at their sides for example by welding, as best shown in Figures 5 and 11. The ends of

the plates are attached, by welding, to concentric annular or ring girders 8. Alternatively, the outer ends of the plates in annular ring 4 can be attached to the sides of a structure of the type indicated above. The ring girders 8 are attached to and supported by suitably spaced, vertically extending columns 9. The innermost portion of the roof is a dome 10 which is welded to a ring girder 8 at its periphery.

The roof 1 can be composed of curved plates which possess inherent structural stability or of flat plates which are less expensive to manufacture than curved plates. Flanged plate 5 takes the form of either a stiffened, curved trapezoidal plate 5a shown in Figures 1 and 4, a stiffened, curved rectangular plate 5b shown in Figures 15, 16 and 17, a stiffened, dished trapezoidal plate 5c shown in Figures 6, 9 and 10, or a stiffened, dished rectangular plate 5d shown in Figures 18 and 19. Each of the stiffened, flanged plates has sufficient vertical section to render it sufficiently rigid to prevent it, as well as the plates with which it is associated, from bending from normal dead and live loads. Stiffened, flanged plates 5a and 5b have stiffening ribs 12 and 15, respectively, while the stiffened, flanged plates 5c and 5d have dished portions the longitudinally extending sides of which are in the nature of stiffening ribs. Due to the fact that these flanged plates 5a, 5b, 5c and 5d have substantial vertical section the associated non-stiffened, trapezoidal and rectangular plates are adequately supported thereby.

The stiffening ribs are preferably made to extend outwardly from the webs 11 and 14, that is, they

are attached to the web at an interior angle greater than 90 degrees, whereby a plurality of the plates 5a and 5b can be conveniently nested for packing and shipping. Plate 5a comprises a flat trapezoidal longitudinally extending web 11, stiffening ribs 12 which extend from and are perpendicular to the longitudinally extending sides of the trapezoidal web 11, and longitudinally curved flanges 13 extending perpendicular to each of the stiffening ribs 12. The stiffening ribs 12 have relatively long non-parallel edges and range from a minimum at each end thereof to a maximum at about the center thereof. The stiffening ribs 12 each have one straight edge attached to the flat trapezoidal web 11 and another curved edge the ends of which intersect said straight edge, whereby said edges define an area bounded by an arc and a cord of said arc. Plate 5b comprises a flat rectangular longitudinally extending web 14, stiffening ribs 15 which extend from and are perpendicular to the longitudinally extending side of the rectangular web 14 and longitudinally curved flanges 16 extending perpendicular to each of the stiffening ribs 15. Plate 5c comprises a substantially trapezoidal plate having side edges 17 which lie in a plane. The portion of the plate 5c which lies within the side edges 17 is a trapezoidal dished portion 18. Plate 5d comprises a rectangular plate having side edges 19 which lie in a plane. The portion of the plate 5d which lies within the side edges 19 is a rectangular dished portion 20.

Plate 6 takes either the form of a non-stiffened, curved trapezoidal plate 6a or a non-stiffened, flat trapezoidal plate 6b, and similarly, plate 7 takes either

the form of a non-stiffened, curved rectangular plate 7a or a non-stiffened, flat rectangular plate 7b depending upon whether the roof is to be composed of curved or flat plates. Thus, when a roof having curved or arched plates is desired, then arch tie plates 5a (or 5b), and curved or arched plates 6a and 7a are employed and secured together to form a series of tied arches, and when a roof having flat plates is desired plates 5c (or 5d), 6b and 7b are employed. The plates 5a and 5b are each usable with plates 6a and 7a. The basic difference between arch tie plates 5a and 5b is that the flat portion 11 of plate 5a is of a trapezoidal shape, while the flat portion 14 of plate 5b is of a rectangular shape. The plates 5c and 5d are each usable with plates 6b and 7b. The basic difference between plates 5c and 5d is that plate 5c is of a generally trapezoidal shape while plate 5d is of a generally rectangular shape.

The ends or bases of the plates 5, 6 and 7 have a slight radius so that they better conform to the curvature of the ring girders 8 to which they are attached.

In a specific example of a roof built in accordance with this invention, the length of each of the plates is twenty-four feet, the width of the trapezoidal plates is six feet at one end and sixteen inches at the other end, the rectangular plates are six feet wide and the dome is twenty-four feet in diameter. The plates 5, 6 and 7 all have a thickness of 0.1875 inch. Due to the fact that the plates are attached in the overlapped position the effective cover area of the plates is slightly less than that defined by their maximum dimensions. Therefore, this roof having three annular rings covers a circular area one hundred and sixty-eight feet in diameter. The curved plates have a curved height of fourteen inches

at their longitudinal center. This specific example is illustrative only and is not in any way intended to be a limitation on the invention.

Different dimensions, if desired, can be selected in order that a different combination of plates can be used to achieve a regular and precise fit of sufficient strength to support normal dead-load and live-load bending stresses. It is desirable to standardize all dimensions in order to be able to produce the required number of plates from a single die, to stock the various types of plates, and thereby to have a wide variety of roof sizes available for immediate construction at low cost.

In the first annular ring, if its inside diameter is small, the rectangular plates can be omitted, so that only the trapezoidal plates will be used. Ideally, the flanged trapezoidal and flanged rectangular plates will be shaped so as to be easily stacked for shipment, by slightly sloping the web portions thereof.

If the radius of the area to be covered is not some multiple of the longitudinal span of the plates, then the radius of the central dome will be selected so as to permit the outer ring of plates to extend to the edge of the area to be covered. In such case, the circumference of each ring may be such that one of the plates of each ring of plates must be trimmed along a longitudinal edge in order to effect a closure of each ring. Normally one of the flat rectangular plates would be selected to be trimmed to effect this closure.

Adjacent plates should be sealed to each other to make a weather-proof roof. This may be accomplished by means of a sealing mastic, by welding, or by any other known means.

The above-described embodiments being exemplary only, it will be understood that the present invention comprehends organizations differing in form or detail from the presently described embodiments. Accordingly, the invention is not to be considered as limited save as is consonant with the scope of the following claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. In a roof:

a polygonal reinforced arch tie plate;

a pair of polygonal unreinforced arch plates;

each plate having a pair of ends and a pair of sides;

each of said unreinforced arch plates having a curvature consisting of a longitudinal curve upwardly from each end to the center;

said reinforced arch tie plate having a flat web all of which lies in the same plane;

a reinforcing rib extending upwardly along each side of said web;

each reinforcing rib having an upper terminal surface longitudinally curved upwardly from each end to the center of the reinforced rib;

said terminal surface having the same curve as the longitudinally curved unreinforced plates;

and a pair of flanges each extending in a respective opposite outward direction from a respective longitudinally curved upper terminal rib surface;

each flange following the longitudinal curve of the upper terminal surface;

each flange disposed in underlying supporting engagement with a side edge portion of a respective unreinforced arch plate and secured thereto to form a tied arch.

2. In a roof as recited in Claim 1 wherein:

said reinforced arch tie plate has a trapezoidal web, one of said unreinforced arch plates is trapezoidal, and the other unreinforced arch plate is rectangular.

3. A combination of roof plates comprising:

a polygonal reinforced arch tie plate;

a pair of polygonal unreinforced arch plates;

each plate having a pair of ends and a pair of sides;

each of said unreinforced arch plates having a curvature consisting of a longitudinal curve upwardly from each end to the center;

said reinforced arch tie plate having a flat web all of which lies in the same plane;

a reinforcing rib extending upwardly along each side of said web;

each reinforcing rib having an upper terminal surface longitudinally curved upwardly from each end to the center of the reinforced rib;

said terminal surface having the same curve as the longitudinally curved unreinforced plates;

and a pair of flanges each extending in a respective opposite outward direction from a respective longitudinally curved upper terminal rib surface;

each flange following the longitudinal curve of the upper terminal surface;

each flange adapted to be disposed in underlying supporting engagement with a side edge portion of a respective unreinforced arch plate and secured thereto to form a tied arch.

4. In a roof:

a polygonal reinforced plate;

a pair of polygonal unreinforced plates;

each plate having a pair of ends and a pair of sides;

each of said unreinforced plates constituting a flat planar member all of which lies in the same plane;

said reinforced plate comprising an upwardly dished

central portion surrounded by a peripheral flange extending outwardly in longitudinal and lateral directions;

all of said flange lying in the same plane;

said dished portion, in longitudinal cross-section, being upwardly curved from each end toward the center, and in lateral cross-section being upwardly curved from each side toward the center;

said peripheral flange including side portions disposed in underlying supporting engagement with a side edge portion of a respective unreinforced plate.

5. In a roof as recited in Claim 4 wherein:

said reinforced plate has a trapezoidal web, one of said unreinforced plates is trapezoidal, and the other unreinforced plate is rectangular.

6. A combination of roof plates comprising:

a polygonal reinforced plate;

a pair of polygonal unreinforced plates;

each plate having a pair of ends and a pair of sides;

each of said unreinforced plates constituting a flat planar member all of which lies in the same plane;

said reinforced member comprising an upwardly dished central portion surrounded by a peripheral flange extending outwardly in longitudinal and lateral directions;

all of said flange lying in the same plane;

said dished portion, in longitudinal cross-section, being upwardly curved from each end toward the center, and in lateral cross-section being upwardly curved from each side toward the center;

said peripheral flange including side portions adapted to be disposed in underlying supporting engagement with a side edge portion of a respective unreinforced plate.

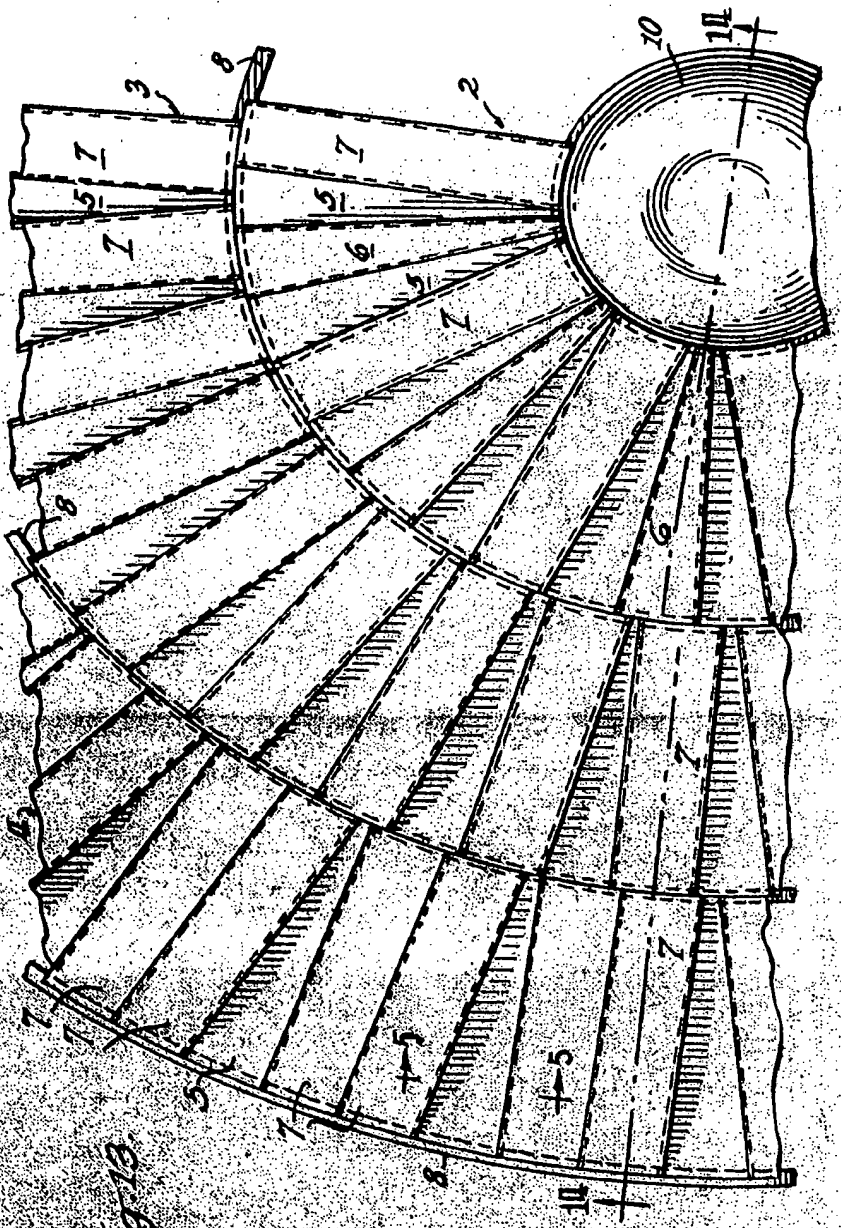

Fig. I

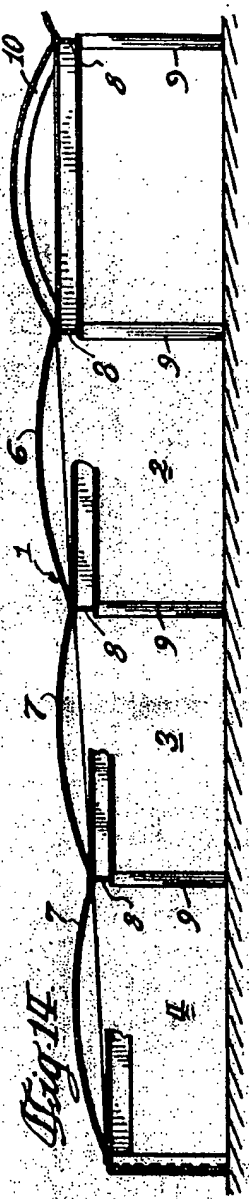

Fig. II

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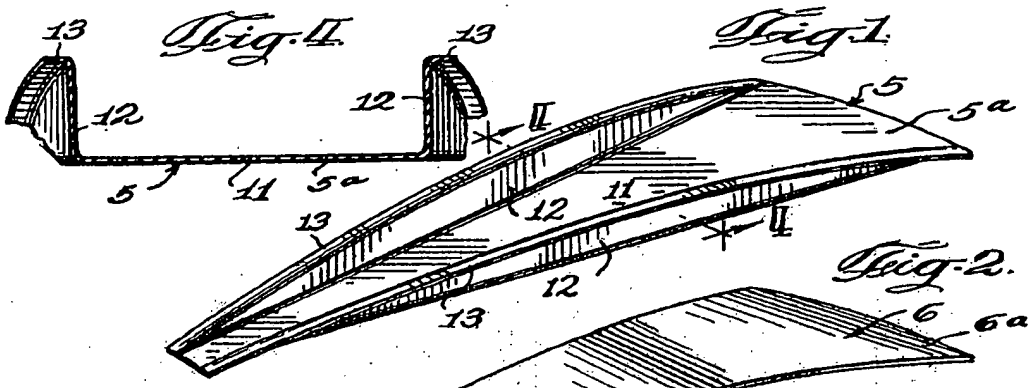


Fig. 1.

Fig. 2.

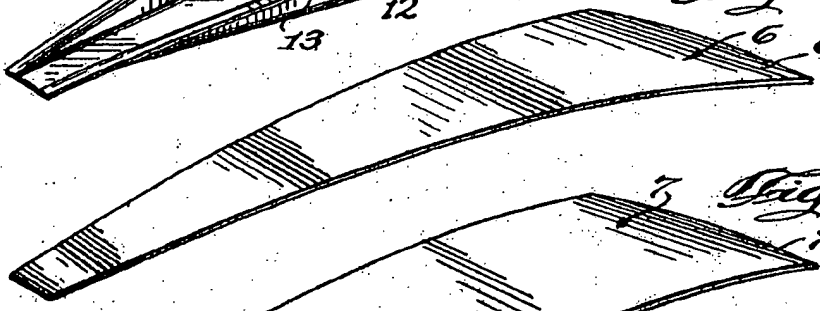


Fig. 3.

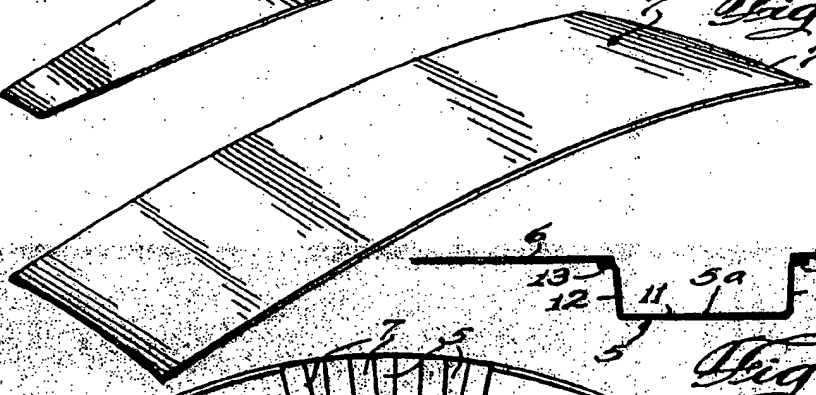





Fig. 5.

Fig. 12.

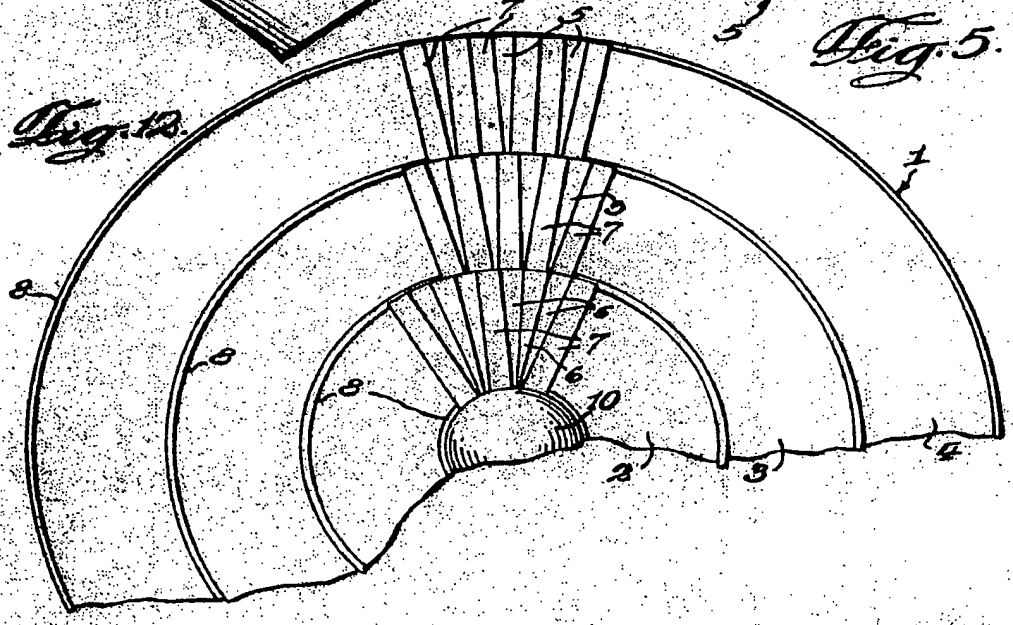


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Fig. 15.

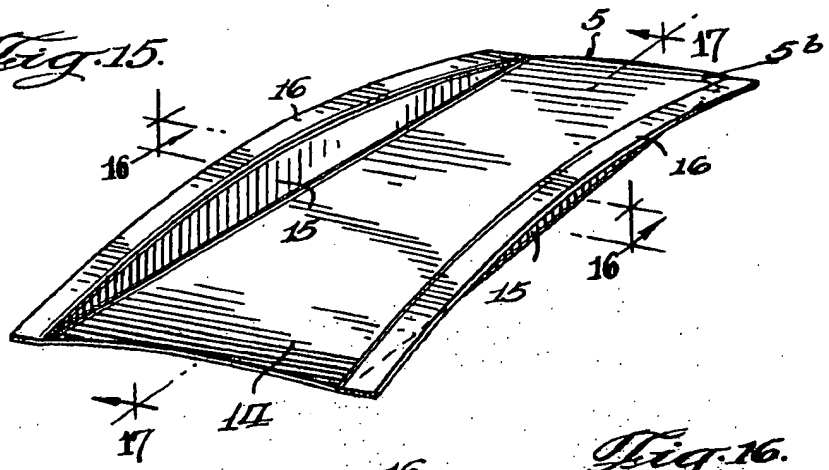


Fig. 16.

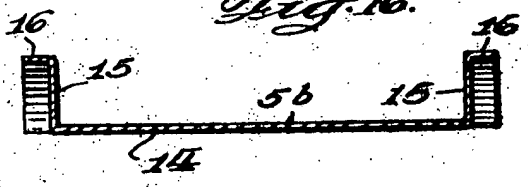


Fig. 17.


Fig. 18.

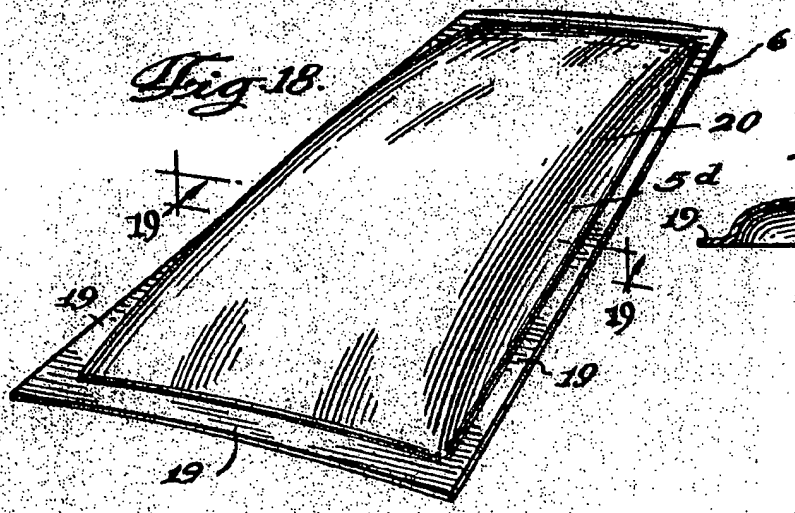


Fig. 19.

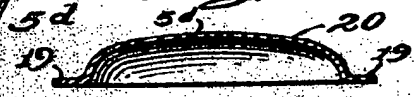


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Fig. 10.

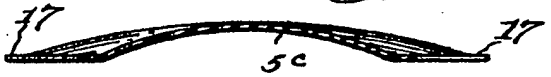



Fig. 6.

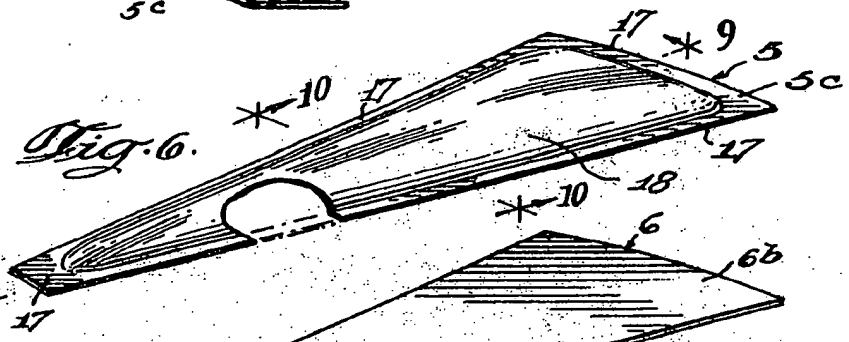



Fig. 7.

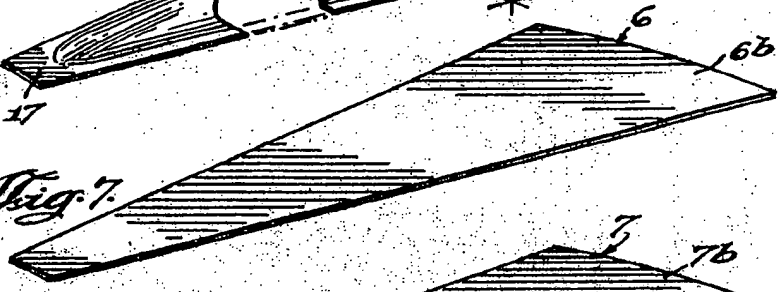



Fig. 8.


Fig. 9.

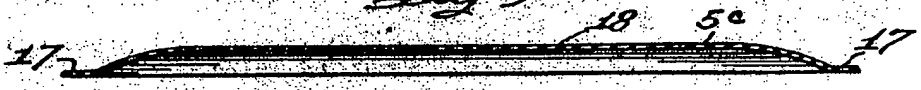
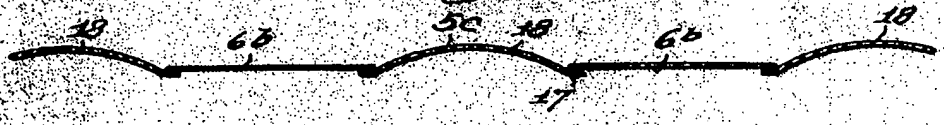



Fig. 11.

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